THE FALL IN THE PRICE OF SILVER SINCE 1873.

THE current price of silver is the exchange ratio between silver and gold, and will change from causes affecting either of its terms. A complete study of the price of silver should therefore properly include some mention of the gold side of its price ratio. The limits of the present article prevent, however, such a study of gold. We shall first examine the price of silver from the standpoint of silver, and only if no satisfactory explanation of its movement can thus be found resort must be had to the agency of gold in producing the price movement.

I. THE DEMAND FOR SILVER.

The money demand for silver has greatly declined within recent years. This is due to the general closing of the mints of the world to its free coinage; and to its reduction to the position of token money.[1]

We cannot ascertain with any exactness the strength of the demand from the arts. It has probably been stimulated by the increasing cheapness of silver; but there is no evidence that it has increased sufficiently to offset the decreased demand for coinage purposes.

[1] This weakening of demand is shown in the following table, taken from the *Report of the Director of the Mint* for 1896. It will be observed that the world's coinage bears a decreasing ratio to the yearly production of silver.

Year	Production of silver, in fine ounces	World's coinage of silver, in fine ounces
1888.....	108,827,606	104,354,000
1889.....	120,213,611	107,788,256
1890.....	126,095,062	117,789,228
1891.....	137,170,119	106,962,049
1892.....	153,151,762	120,282,947
1893.....	165,472,621	106,697,783
1894.....	164,610,394	87,472,523
1895..... ...	168,308,353	94,057,903

The Indian demand next claims our attention. India and the East annually absorb large quantities of silver, most of which is hoarded by the natives.[1] If these importations of silver increased to any large extent the monetary circulation of these countries, the favorable balance of trade which has caused the movement would be quickly corrected by a rise of prices. Such, however, is not the case. Even in times of famine a relatively small amount of silver is sold.[2] Of recent years these Indian importations have seriously declined, when compared with the fall in the price. When larger quantities have been taken the increase has not been at all proportional to the downward movement of the price of silver. The Indian demand has gradually weakened.[3]

Some influence in causing this decreased demand must be ascribed to the Council Bills. These are bills of exchange, drawn by the Indian council in London upon the Indian treasury. They are the evidences of debt due to England from India, and are sold to Indian importers who are thus saved the trouble of purchasing and shipping silver to meet their obligations. These council bills thus compete with silver as a means of payment to India. Of recent years this competition has become serious, the average yearly amount of bills sold in the London market having increased from $57,762,790 in the period 1873–1877 to an average of $74,476,166 in the period 1891–1895.[4] The influ-

[1] (*a*) See evidence of Barbour before the Royal Gold and Silver Commission, *First Report*, questions 1095 *et seq.*, and Appendix V, A to D.

(*b*) See also ELLSTAETTER, *Indian Silver Currency* (Laughlin's translation), pp. 8, 9, and 14: "Of the silver thus absorbed, it is certain that only a small part remains in circulation."

[2] ELLSTAETTER, p. 16: " . . . . from 1877 to 1880, famine years, Rx. 4.5 millions of silver ornaments came to the mints of Bombay and Calcutta."

[3] From 1873 to 1877 India imported an average amount of silver of $26,167,066 (taking the rupee at its coinage value) at an average price of 21.49 pence per rupee; from 1885 to 1889 $33,468,359 of silver on the average was imported at a rupee price of 17.10 pence; and from 1891 to 1895 the average import of silver amounted to $29.-036,171 at a rupee price of 14.6 pence.—*Report of the Director of the Mint*, 1896.

[4] *Report of the Director of the Mint*, 1896. Estimated on the basis of the coining value of the rupee.

ence of the council bills in decreasing the demand for silver may easily be overestimated, since they represent in large measure investments of English capital in public works which have largely increased the productive power of India. These investments of capital have thus, to some extent, furnished the means for their own repayment. A point not generally noted is the effect of the manner of sale of these council bills upon the silver market. They are generally put into the market as they become due, without regard to the price of silver or to the needs of exchange, and are sold for what they will bring, thus exerting a most depressing influence upon the market.[1] We may conclude that the Indian demand has been seriously weakened, but that other forces beside the council bills have been active in causing its decline.

Finally, the demand for silver has been progressively inelastic. This is seen (1) from the increasing frequency and extent of its price fluctuations; and (2) from the weakened continental demands which were strong and constant prior to 1873. Since that time Europe has habitually purchased on a declining market, and has ceased buying when for any reason the price has risen.[2]

To summarize our discussion of the demand for silver: we find (1) that the proportion of the yearly supply entering the world's currencies has constantly declined; (2) that there is no evidence of an increased demand from the arts sufficient to offset the decreased demand for coinage; (3) that the Indian demand has been seriously weakened; and (4) that the world's demand for silver has been progressively inelastic.

In passing to the discussion of the supply of silver, we

[1] *London Economist*, February 18, 1882, and February 24, 1883.

[2] Purchases of European countries, showing that these coincided with the periods of depression in the silver market:

(*a*) Portugal, 1876, 1878, 1887, 1892 (*United States Treasury Report*, 1895, p. 349).
(*b*) Italy, 1893, 1894 (*ibid.*).
(*c*) Netherlands, 1891, 1894 (*ibid.*, p. 352).
(*d*) Spain, 1877–1879, 1886, 1891, 1893–4 (*ibid.*, p. 348).
(*e*) Russia, 1891–2 (*ibid.*, p. 352).

should note that the generally accepted theory of the value of the precious metals has considered the total stock in existence as the supplies, upon which new demand influences must operate in order to affect their values. The effective regulation of these supplies has been excluded from the domain of cost of production in consequence.[1]

In its application to silver, some modification of this theory is necessary. Only that portion of a commodity can affect its price which is either actually, or, in the opinion of the dealers, potentially, within the market looking for purchasers. On this understanding of supply, we must exclude from the marketable stock of silver (1) most of the silver which has entered the arts, since this will be put on the market in relatively insignificant amounts; and (2) that portion of the world's silver money which is sustained at a face value above its bullion value by a process of direct or indirect redemption. If these limitations be accepted in full, the available supply of silver must be restricted to an amount but slightly in excess of its yearly production.[2] In this case it is upon this relatively small amount that new demand influences must operate. But when we examine more closely this latter principle in its applicability to the conditions prevailing in the silver market since 1871, it is by no means to be accepted as thus absolutely stated. During the greater part of this period, certain peculiar circumstances affecting silver compel us, to some extent, to resort to the old view of the supply, in order to understand its influence upon the price.

[1] So, *e. g.*, J. S. MILL, *Principles*, bk. iii. chap. vi. § 2.

[2] The *Report of the Director of the Mint* (1895, pp. 39–41) shows the stock of silver money in those countries which at that time admitted silver to free coinage and full legal-tender privileges to be $1,015,000,000; those with limited tender and restricted coinage, $3,085,500,000. From the first amount should be substracted (1) the silver of China amounting to 750 million dollars; and (2) that of Japan, amounting to 72 million dollars. The silver of China is exceedingly immobile, and Japan has only recently adopted the gold standard. The remaining silver-standard countries are India, the Straits Settlements, Mexico, and South and Central America. When the small use of credit and the consequent large use of money in these countries is considered, the probability of any large part of their silver entering the market is seen to be slight.

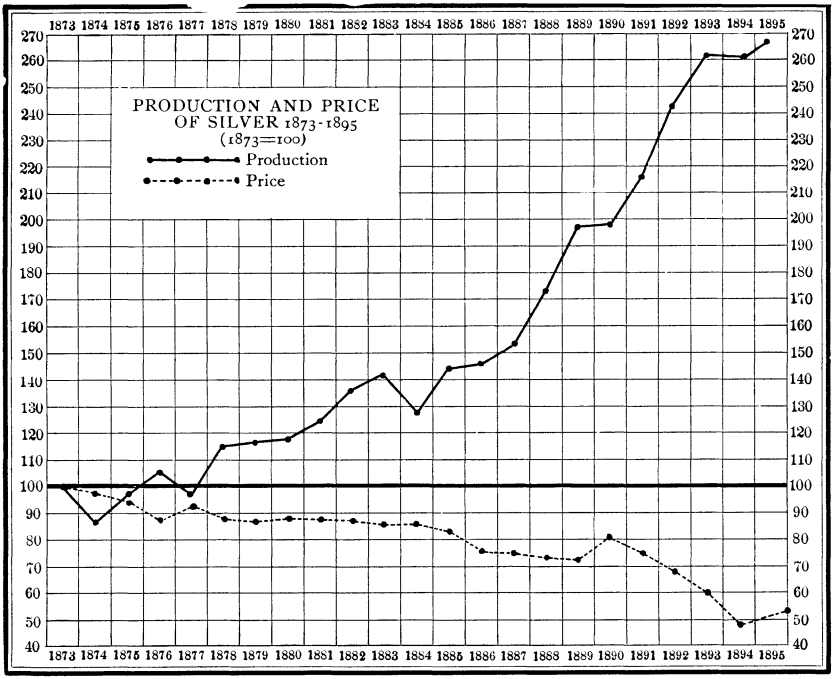
The fear has been constantly present in the silver market that some of those nations holding large amounts of silver tokens would throw these stocks upon the market. This apprehension was particularly strong in the case of Germany. A general ignorance existed during the period of the sales of silver by this government as to the amount of silver which it intended to dispose of. This was evidenced in the depressing influence which the actual sales exercised upon the price, an influence out of proportion to their actual extent, and also by the quick recovery which followed Bismarck's announcement in 1879 that the German sales would be suspended.[1] It was feared at one time that the dissolution of the Latin Monetary Union would throw a large quantity of silver on the market.[2] At a later date the Austrian silver has given trouble;[3] and only recently, the action of Japan in adopting the gold standard has depressed the silver market, because it was feared that Japan might sell her silver.[4] It is true that these fears have not to any extent been realized; but they have exercised considerable influence upon the silver market notwithstanding, and should be reckoned with in a discussion of the supply of silver. In estimating this available supply, we must therefore take account not only of the yearly production, but of that large quantity of token silver which has, for so many years, threatened the market. Keeping this fact in mind, reference should now be made to the accompanying chart which shows the relative movements of the production and price of silver from 1873 to 1895. The production has increased 266 per cent., and this, as we have seen, does not represent the actual

[1] *Report of the Royal Commission*, 1888, p. 146, evidence of Paul Tidman: "Because . . . . there had been thrown upon the market the quantity of German silver with the prospect of more to follow." *Ibid.*: "But you had a large amount of silver held *in terrorem* over the market by Germany." See also *London Economist*, January 10, 1874, March 13, 1875, and March 9, 1878; and *London Standard*, December, 1879.

[2] *London Economist*, September 12, 1885, ". . . . apprehension as to the future of silver . . . . which has recently been revived and intensified . . . . by the threatened disruption of the Latin Monetary Union." See also *ibid.*, September 19, 1885.

[3] VON WIESER in this JOURNAL, vol. i. p. 404, June 1893.

[4] *London Economist*, March 20, 1897.



PRODUCTION AND PRICE OF SILVER, 1873 TO 1895.

(*Report of the Director of the Mint*, 1896.)

Year	Production, fine ounces	Per cent.	Price of silver per ounce in pence	Per cent.
1873	63,267,187	100	59 1/4	100
1874	55,300,781	87.5	58 5/16	98.4
1875	62,261,719	98.3	56 7/8	96
1876	67,753,125	107	52 3/4	89
1877	62,679,916	99	54 13/16	92.5
1878	73,385,451	116	52 9/16	88.7
1879	74,383,495	117.5	51 1/4	86.5
1880	74,795,273	118.2	52 1/4	88.2
1881	79,020,872	124.7	51 11/16	87.6
1882	86,472,091	136.6	51 5/8	87.5
1883	89,175,023	140.9	50 9/16	85.5
1884	81,567,801	128.9	50 5/8	85.7
1885	91,609,959	144.7	48 5/8	82.6
1886	93,297,290	147.4	45 3/8	76.6
1887	96,123,586	151.9	44 5/8	75.3
1888	108,827,606	172	42 7/8	72.4
1889	120,213,611	198.8	42 11/16	72.1
1890	126,095,062	199.3	47 11/16	72
1891	137,170,919	216.9	45 11/16	80.6
1892	153,151,762	242	39 13/16	76.1
1893	165,472,621	262.5	35 5/8	67.4
1894	164,610,394	260.4	28 15/16	60.2
1895	168,308,353	266	29 1/8	48.9

increase in the available supply of silver. The price has fallen 98 per cent.

We have seen that the demand for silver has declined since 1873. If this fact be taken in connection with the increase in supply, the fall in the price of silver is adequately explained. A careful study of the influences affecting gold might assign to it some influence in depressing the price of silver; but from the relative movements of the supply and demand of silver itself, this influence of gold would plainly be insignificant, even if it has not, by increasing in quantity, to some extent prevented a greater fall in silver than that which has actually taken place.

II.

THE COST OF PRODUCTION OF SILVER.

This increase in the supply of silver at the same time that its price was falling proves either (1) that its cost of production has been greatly lessened, or (2) that its price was originally so far above the cost of production that in its decline it has not yet reached a point where cost can regulate supply.

It is impossible accurately to estimate the average cost of production of silver. It is produced by all grades of mining operators; much of it is found in connection with gold, lead, and copper, thus assuming the character of a by-product; the yield of different mines varies widely; and that of the same mine from year to year. In our discussion of the cost of production of silver we must be content to trace the general progress of the silver industry, noting a few of the most important improvements both in methods and machinery.

(1) The first and most important improvement in silver production has been the improvement in transportation. Railroads have been rapidly extended throughout the western part of the United States,[1] and of recent years into Mexico. The building of these latter roads has made possible the importation of silver ores from Mexico into the United States, which greatly stimu-

[1] From *Poor's Manual*, 1895, table showing extension of railroads in the principal mining states of the United States:

lated the silver industry of the former country.[1] Railroad transportation enables the shipping of fuel and timber, frequently scanty in the richest mining localities; and also the introduction of the improved machinery, without which, except in the richest deposits, silver mining cannot today succeed. Transportation facilities also make it possible to utilize lead as a by-product of silver, which materially decreases the cost of silver production. Difficulties of transportation have seriously retarded the progress of silver mining in Bolivia. A railway has, however, recently been in process of construction in that country which will open some of the richest mines. This railway now rises more than 4000 feet to the mines of Huanchaca and Oruco, and will be extended farther.[2] Steamers now run on Lake Titacaca. By means of these transportation facilities many of the Bolivian mines have been equipped with improved machinery, and have largely increased their output.[3] When it is known that, until recently, in Bolivia, most of the ore and supplies were transported on men's backs, or on the backs of llamas; and that, in many localities, the dried dung of the llama was the only fuel, the influence of transportation facilities upon the future of South American mining industry can be comprehended.[4]

One of the most interesting improvements in mining is the "rope haul," which is in use in many mining localities situated near the seaboard, in the transportation of ore to the

TABLE SHOWING EXTENSION OF RAILROADS IN THE UNITED STATES.

States	1860	1870	1880	1890
California	23	925	2,195	4,328.03
Nevada	..	593	739	923
Arizona	..	...	349	1,094.81
Utah	..	257	842	1,265

[1] ROTHWELL, *Mineral Industries*, 1894, pp. 284, 285.

[2] *Report of the Director of the Mint on the Production of the Precious Metals*, 1894, p. 218. *German Monetary Commission*, 17th–20th sessions, p. 84. ROTHWELL, *Mineral Industries*, 1894, p. 285.

[3] Production of Bolivia 384,985 kilos in 1885, 21,999,966 oz. in 1894.—*Report of Director of the Mint*, 1886 and 1895.

[4] *Report of German Monetary Commission*, pp. 82–4.

coast. This consists of a continuous wire rope, running over drums at either end of the line, to which the ore buckets are attached. This appliance is usually operated by steam power, but in some localities, where the fall in grade is constant, the force of gravity has been found sufficient — the loaded buckets in their descent carrying the empty ones back to the point of loading.

Next in importance to the improvements in transportation come those in the mechanical and chemical processes of mining and extraction of ore. We may divide these as follows: improvements in extracting and dressing the ore, and improvements in methods of treatment.

Under the first, the steam, and later the electric hoist, has been substituted for the handwindlass.[1] Immense improvements have been made in the construction of concentrators. The old method of concentration, which is still in use in Mexico, and at some mines in the United States, was that of hand picking. The ore was spread out in a yard, and broken several times by hand; after each breaking being carefully sorted by women and children, who throw out the worthless material. The latest concentrator consists of a broad rubber belt revolving in an inclined trough. As the crushed ores are fed to the upper part with a stream of water, the lighter waste is washed down, while, the belt, also receiving a constant series of sharp lateral impulses carries the ore up the trough into the receiver. The latest form of this machine is capable of treating from ten to fifteen tons of ore per day.

The improvements in sampling ores have been even more striking. The object of sampling is to ascertain with approximate exactness the number of ounces per ton which the ore contains. The old method of sampling was to spread the ore in a layer, stretch a tape across it, and select pieces of ore at each foot mark. A pile was then made of this selected ore, which was carefully shoveled over several times, and then quartered; three

[1] Information obtained from Fraser and Chalmers, Manufacturers of Mining Machinery, Chicago, Ill.

pieces being thrown into one pile, and one into another. The smaller pile was run through a crusher and the crushed ore was made into a conical pile and again quartered, the opposite quarters being saved. This process was several times repeated, the ore being more finely reduced at each stage, till it was finally ready for the assayer.[1] Contrast this with one of the later samplers. A number of funnels of varying diameters are superimposed one upon the other, space being left between them for the ore to pass freely from the top of the series to the bottom. These funnels are kept revolving by machinery in such a manner that a certain proportion of the ore, which is constantly fed into the mouth of the upper funnel, will pass through openings in their sides at each revolution. The main bulk of the ore goes back to the sheds, while that which has been extracted is again put through the sampler, and is then ready for the assay office. The entire process is automatic.[2]

Great improvements have also been made in ore crushing. For the bowlder-crusher of Bolivia and Mexico,[3] has been substituted the battery of stamps and the rolls, and both of these have undergone a long series of improvements which space does not allow me to enumerate.[4] A large amount of labor has been saved by the manner of construction of the smelting works. "All refining works are now built in terrace form, and are so arranged that the base bullion, which has necessarily to be handled while being unloaded, sampled, and charged into the softening furnace, shall run from one furnace to another and not be lifted again until it is loaded."[5]

[1] *Transactions of the American Institute of Mining Engineers*, vol. xx. p. 155 (June 1891). Many of the old processes herein described are still in use, but they are rapidly being superseded by the more improved appliances.

[2] *Ibid.*, vol. xxii. p. 321 (August 1893).

[3] "A large bowlder with a short pole lashed to the top with rawhide, to serve as a lever in rocking it with a pump-handle motion back and forth through the segment of a circle of about five feet in diameter, over a flat bed stone upon which the metal is thrown so as to be caught under the rocking bowlder."—*Report of the Director of the Mint on Production of Gold and Silver in the United States*, 1891, p. 97.

[4] *Transactions A. I. M. E.*, vol. xiv. p. 497.

[5] ROTHWELL, *Mineral Industries*, 1892, p. 325.

In the smelting proper improvement has been even more active than in the preliminary operations. Those ores which contain sulphur in any considerable quantities require generally to be roasted in order to expel the sulphur before being thrown into the furnace. In former times these ores were roasted in heaps in the open air. Simple furnaces were next introduced, but it was found that even with this improvement success in roasting depended altogether on the care and skill of the man in charge, and many accidents were constantly occurring. This necessitated the construction of improved furnaces which require little or no skill on the part of the operator.[1] Much silver was formerly lost in the dust of the furnace. This difficulty has been overcome by special dust chambers with auxiliary flues, in which the roasting goes on uninterruptedly, all the ore which was formerly wasted being thus saved and immediately utilized.[2] In the treatment of "dry" silver ores, which are amalgamated with quicksilver and retorted, the chief improvement of recent years has been in the saving of quicksilver. Much of this was formerly wasted, the ground under some of the old smelting works being literally saturated with mercury. Strainers have now been introduced which separate the quicksilver from the amalgam. Mercury elevators, which are series of cups on endless chains, are then employed to raise the metal to the receiving tanks.[3] Coincidently with this saving of quicksilver has come a great fall in its price, which has declined from $80.32 per flask in 1873 to $38.80 in 1892.[4] Marked advances have also been made in the construction of amalgamating pans and settlers. The methods employed in extracting high-grade ores present a marked contrast to the patio process, which is still in vogue in Mexico. Here the ore is broken up, usually by hand, and is

[1] EGGLESTON, *Metallurgy of Silver, Gold, and Mercury in the United States*, p. 227: "The whole operation is under control from beginning to end, and the whole work of roasting the ore, (1) introducing, (2) drying, and (3) carrying it off, is entirely automatic."

[2] *Ibid.*, p. 228.

[3] EISSLER, *Metallurgy of Lead*, pp. 158, 159.

[4] ROTHWELL, *Mineral Industries*, 1892, p. 409.

then ground in what is known as an "arrastre," shaped like a horizontal waterwheel, in which heavy stones are used to do the grinding, and which is worked by mule power. In this the ore is mixed with water and ground to a pulp. It is then placed in what is known as the patio, a large basin usually with several hundred square feet of surface, where it is left for the water to evaporate until the mass is of the consistency of brick clay. Salt is then added, and the mass is thoroughly tramped by mules, after which quicksilver is added. After another treading a hot solution of sulphate of copper is added. Several more treadings follow. The mass is then washed by being run through a settler, inside which two men keep it in constant motion by treading. The amalgam, when washed, is put into iron flasks and heated to free it from the mercury. The silver comes out in the shape of spongy bars. The cost of working is very great. At one mill, where the ore averaged $60 per ton in Mexican silver, the average cost of working was $27.58, which does not include the wages of superintendence and interest. The method is evidently both expensive and tedious. Large amounts of ore, quicksilver, and amalgam are lost in the frequent handlings, which afford excellent opportunities for pilfering. Large quantities of tailings are collected, which must be concentrated and shipped. Another disadvantage is the time required. The process usually occupies not less than four weeks[1] and the interest loss is very considerable.

The methods of extraction of high-grade silver in vogue in the United States, and in the best mills throughout the world, may be summarized as follows: The ore is hauled to the mill, is sifted and sorted by machinery, crushed by heavy stamping batteries with a capacity of five tons to the head, or by the rolls, after which it is carried directly to the amalgamating pans, in which it is kept constantly in motion by machinery, passing through the eight pans in four hours. From these the pulp

[1] This description of the patio process is taken from a paper by Richard Chism found in *Transactions A. I. M. E.*, vol. xi. pp. 61–78. At this time silver was worth 51⅝ pence per ounce.

passes into settlers, which clean up the charge of 1000 pounds in four hours more. The mass is then retorted. The average cost for an average mill in Arizona was from $3.12 to $4.90 per ton of ore.[1]

The remaining processes of silver reduction may be divided into: (1) the group of leaching processes for low-grade ores; and (2) the smelting processes for galena and zinc-lead ores. Of the first the Russell process may be taken as a fair example. This was introduced about 1884. The essence of this process is to get the silver into a soluble state and dissolve it out with water. This is accomplished by the conversion of the silver into silver chloride by roasting with salt, and by the treatment of this chloride with a solution of hypo-sulphide of soda or lime. This process has proved particularly successful with low-grade ores which could not be treated by the old methods.[2] Another problem which has until recently baffled the silver producer has been the profitable reduction of zinc-lead ores. As late as 1892 it was impossible to reduce these profitably by the ordinary methods of smelting.[3] The zinc volatilized at a high temperature, rising to the top of the furnace and choking the mouth. These ores contain considerable quantities of silver, and constant efforts have been made toward their utilization. Only recently have these experiments been successful. Several methods are now in vogue. One of the best is that introduced by Mr. Ashcroft, a young English mining engineer, at Cockle Creek, Australia.[4] This is called the electrolytic process. The zinc-lead sulphide is made the anode of an electrolytic bath containing an acid element. The metals then enter into solution, and pass over to the cathode, while the sulphur is left behind. By properly regulating the current it has been found possible to separate the zinc by itself, thus getting rid of this troublesome element.

The improvements in lead-silver extraction have been perhaps more notable than any others. Prior to 1874 these ores

[1] *Transactions A. I. M. E.*, vol. xi. pp. 91–106. The cost is in gold.

[2] *Ibid.*, vol. xiii. p. 47. C. A. STETEFELDT.

[3] ROTHWELL, *Mineral Industries*, 1892, p. 316.

[4] *Australian Mining Record*, January 1897.

were reduced by amalgamation, as ordinary dry ores. About that time it was discovered that this silver could be far more easily extracted by a process of smelting. Following this discovery came the great development of Leadville and Pueblo in the early eighties. The essentials of this method of extraction are: (1) the smelting of the ore in an ordinary blast furnace; (2) the concentration of the silver into a much smaller quantity of lead; (3) the separation of the silver in a cupelling furnace.

The blast furnace has been greatly improved during the last twenty-five years. With the new era of lead smelting began careful investigations into the composition of the slag, and smelting was put on a scientific basis. Water-cooled jackets were soon substituted for fire-brick, and the life of the furnace was thus greatly prolonged.[1] Many improvements have been made in the furnace appliances, chief among which is the Arent syphon-tap, which allows the molten lead containing the silver to float away from the mass and be ladled out into the carriers, instead of flowing out as was formerly the case.

Marked improvements have taken place in the concentration processes. By the old method, the molten lead was placed in a number of kettles and allowed gradually to cool, the silver-lead alloys, which crystallized during the process, being dipped out by hand. This operation required much time and labor, and was correspondingly expensive. The present practice is to mix zinc with the molten lead, which takes up a large part of the silver, rises to the surface, is then skimmed off, and the zinc distilled out. The lead, containing the remainder of the silver, is finally placed on the floor of the cupelling furnace, a circular structure with a dome shaped roof and provided with a tuyere for the application of a hot blast, and an outlet opposite the tuyere opening. When the blast is applied, the lead is oxidized and blown through the outlet in the form of litharge, leaving the silver on the floor of the furnace, which is built on trucks apart from the main body of the structure. This construction enables the entire floor to be drawn out with the silver. The

[1] ROTHWELL, *Mineral Industries*, 1892, pp. 322, 323, 324.

old method was to take off the top of the furnace in order to get at the silver. Other improvements in the cupelling furnace have been in the application and nature of the blast.[1]

An important feature of the general improvement in the silver industry has been the rapid introduction of electricity into mining operations. The use of the electric light has greatly facilitated all processes carried on within the mine. Electric power is also employed in hoisting ore, and in pumping, with the very best results both as regards cost and convenience.[2] Electricity can be transmitted long distances with only a small loss of power; and it is thus possible to use power at such a distance from its source as would render it otherwise unavailable.[3] The importance of this improvement can be better realized when we consider that one of the greatest obstacles which mining, especially in Mexico, has to encounter is the difficulty of obtaining fuel for power owing both to the lack of transportation facilities, and, where these exist, to the high charges for hauling coal from the United States. By the introduction of electricity, this problem is, in large measure, solved. Where water-power exists within a radius of fifty miles, it can be used for the transmission of electric power to a silver mine. The economy of power is very remarkable.[4] At one set of mines in Mexico, those operated by the Real Del Monte works, electric power is obtained from Regla Falls, and transmitted from fifteen to twenty-five miles to work pumps, hoists, stamp-mills, crushers, and ventilators.[5]

It is obvious that the results of this long series of improvements in silver mining and silver smelting have been greatly to lower the cost of producing silver. These improvements have

[1] ROTHWELL, *Mineral Industries*, 1892, p. 327 *ibid.*, 321. "In the early days of lead smelling, ores containing less than $100 per ton of silver could not be worked with profit. The methods employed were so imperfect that losses of 40 per cent. of lead, and 30 per cent. of silver were not uncommon."

[2] *Engineering Magazine*, April 1897.

[3] *Transactions A. I. M. E.*, vol. xx. p. 316.

[4] ROTHWELL, *Mineral Industries*, 1894, p. 669; *cf.* also *Engineering Magazine*, April 1897.

[5] ROTHWELL, *ibid.*, 1895, p. 789.

doubtless, to some extent, been accelerated by the falling price of silver, which they have also tended to produce.[1] It was not to be expected that the great advances which have characterized every other department of industry would not affect the production of silver, and it should be remembered that there is no reason to believe that this march of improvement will be stayed. To take but one illustration: If the experiments in the utilization of the direct heat of the sun are ever successful the smelting of all kinds of ores will be completely revolutionized. The problem of fuel will have been solved.

[1] All appliances for the receiving, sampling, and general handling of materials (ore, fluxes, fuels, intermediary or finished products) are now of such a character as to reduce labor and time about one-half. It may be said that while ten years ago it took two men to smelt a ton of ore, one man is sufficient for the purpose now.—ROTHWELL, 1891, p. 321.

TABLE SHOWING IMPROVEMENT IN SMELTING INDUSTRY.

Place	Year	Contents in silver per ton	Percentage of total value returned to miner
		Oz.	Per cent.
Black Hawk	1871	100	65
	1872	100	65
	1873	100	65.5
	1874	100	53.6
	1875	100	60
	1876	100	67.2
	1877	100	64.3
	1878	100	65
Argo	1879	100	70
	1880	100	74
	1881	100	74
	1882	100	76
	1883	100	76.8
	1884	100	81
	1885	100	77
	1886	100	80
	1887	100	80
	1888	100	82
	1889	100	84

Transactions A. I. M. E., vol. xviii. p. 59. Presidential address of Richard Pierce: "If it were not for the great improvements which have been made from time to time to cheapen the cost of smelting, silver mining would have received its death blow long ere this. . . . . The cost of mining has been largely reduced by improved facilities for transportation, by cheaper labor, and by cheaper materials, enabling him to sell at

The second and most important element of the production of silver is the supply of ore. It is probable that the richest mines in the United States have been exhausted, since the silver industry has received a tremendous development within recent years, and the country has been pretty thoroughly prospected.[1] Notwithstanding the great depression which has affected the silver industry in the United States since 1892, and the low price of silver which forced large numbers of mines to suspend operations, the production of this country, which had declined from 63.5 million oz. in 1892 to 49.5 million oz. in 1894, rose to 55,727,000 oz. in 1892[2] in spite of

a profit ores that formerly were worthless. These same elements have, of course, helped the smelter to a still greater degree, and there is yet room for further development."

The chronology of the principal discoveries begins about 1867.

1867. Discovery of rich deposits of silver ore at White Pine, Nevada.

1868. Emmet mine discovered. Discovery of the Sierra Nevada bonanza.

1869. Discovery of the Eureka lead mines. Sutro tunnel to open Comstock lode commenced October 19 of this year. Discovery of silver ore at Pioche, Nevada. Copper-silver ore discovered at Butte, Montana.

1870. Great silver deposits discovered at Caracolles in Chile.

1871. Discovery of the Great Crown Point, Belcher bonanza in the Comstock.

1872. Discovery of silver at Georgetown, New Mexico.

1873. Discovery of the big bonanza in the Comstock.

1874. Discovery of promising silver mines, including the Silver King in Pinal Range, Arizona. Discovery of rich mines at Leadville.

1875. Discovery of rich silver-lead ore at Frisco, Utah; also, the Horn Silver mine, opened in this year.

1876. Discovery of rich silver veins at Silver Cliff, Colorado. Silver Reef mines in Washoe county, Utah, are opened.

1877. Many new discoveries at Leadville, and Tombstone, Arizona. Discovery of the silver-lead deposits of Sierra Mojuda, Coahuiha, Mexico.

1878. Important discoveries at Aspen, and in the San Juan region, Colorado.

1881. Discovery of silver ore at Lake Valley, Mexico, and in Calico district, California.

1883. Broken Hill discovered.

1885. Discoveries of the silver lead in the Cœur d'Alene, Idaho.

1890. Silver-lead smelting industry established in Mexico.

1891. Discoveries at Creede.

—See ROTHWELL'S *Mineral Industries*, 1892, pp. 229–232.

[1] *Cf. Report of German Monetary Commission*, 17th–20th sessions, pp. 105–108.

[2] *Report of the Director of United States Mint*, 1891.

the constant decline in price. This would seem to indicate that the possibilities of silver production in the United States are by no means exhausted. The large quantities of zinc-lead ores which exist in Colorado and Arizona offer a wide field for the application of the new discoveries in the methods of their reduction.[1]

The deposits of silver ore of all kinds in Mexico are of enormous extent. Especially in the western portion, in the region of the Sierra Madre, unlimited quantities of low-grade ores are located. It should be remarked that throughout most of the silver districts of Mexico only the high-grade ores have been worked, and that it has been from these that the great expansion in Mexican silver production has almost entirely been derived.[2]

The ore is transported to the railroad from this region by pack animals. Fuel is very scarce, and this prevents the introduction of improved processes. Railway transportation would immediately solve many of the difficulties of silver production in the Sierra Madre.[3] With the opening of railroad facilities, we may reasonably expect a great increase in the silver production of Mexico. Zinc-lead ores exist in great abundance in the eastern part.

Immense deposits of silver ore are known to exist in Honduras, both virgin ores and those found in the old mines of the Spaniards, which were abandoned at the beginning of the present century. The methods employed at these old workings were exceedingly primitive, and the production was consequently small.[4] Only within recent years has the silver production taken

[1] ROTHWELL, *Mineral Industries*, 1892, p. 316.

[2] Production of Mexico has expanded from 650,000 kg. in 1877 to 1,463,361 kg. in 1894.—*Report of the Director of the Mint*, 1894.

[3] I am indebted for many of the facts regarding Mexican silver production to Dr. Farrington, Curator of the Department of Geology, Field Columbian Museum. *Cf.* also ROTHWELL, *Mineral Industries*, 1892, p. 201: "The mining industry of Mexico at the present time stands in much the same position as that of the United States fifteen years ago, when the era of railway building and the establishment of a great metallurgical industry was just dawning."

[4] At one mine, the Opolica, it is estimated that 200,000 tons of ore are on the

on new activity with the introduction of English and American capital.[1] This development began about 1887, and the old mines are rapidly being equipped with modern machinery. Electric motors are in use in some of the workings. "The silver belt extends clear across the country, and is fully fifty miles wide."[2]

Passing to South America, the most promising field for silver mining is found in Bolivia. The wealth of this country in silver ore is beyond calculation. At the Pulacayo mine, 446 meters below the main level, the veins run 12 feet wide and 130 ounces to the ton of ore. The supplies of silver in sight at this mine are estimated at 50 million ounces.[3] Large amounts of ore still exist in old Potosi. This mine, which at one time produced silver to the value of 10 million dollars per year, was abandoned by the Spaniards at the beginning of this century, and was not reopened till 1889. It has been equipped with the best mining machinery, and a large increase is to be expected in its production. Only a small portion of the old workings have as yet been touched.[4] Senor Jose Maria Dalenci,[5] writing in 1851 of Bolivia, gave the number of mines abandoned as 10,000, and those in operation as 148.

Rich deposits of silver ore are known to exist in Peru, which have only to a limited extent been exploited.[6]

Passing to Europe, large deposits of untouched silver ores are to be found in Spain, Portugal, and Scandinavia.[7] Extensive

dumps which will yield from $10 to $20 per ton. Several million tons of ore are in sight at this mine.—*Transactions A. I. M. E.*, vol. xx. p. 394.

[1] Production of Central American states, 1887, 48,123 kg.; in 1894, 77,641 kg.—*Report Director of the Mint*, 1888 and 1895.

[2] Thatcher in *Transactions A. I. M. E.*, see note 2 above.

[3] *Report of Director of Mint on Production of Gold and Silver*, 1894, p. 208, quoting Alfred St. John, British consul at Lima.

[4] *Transactions A. I. M. E.*, vol. xix. p. 74, Arthur F. Wendt.

[5] *Report of Director of Mint on Production of Gold and Silver*, 1891, p. 98, giving letter from Anderson, U. S. minister to Bolivia: "At intervals of every fifteen or twenty miles within this great silver belt are to be seen the abandoned mines of the old Spaniards. Since that time (1851) the conditions have not materially altered. Most of the recent increase in production has come from the old mines."

[6] ROTHWELL, *Mineral Industries*, 1892, pp. 400–1.

[7] *Report of German Monetary Commission*, p. 100. Evidence of Stelzner.

workings exist in Greece.[1] Large deposits are also found in Japan.[2]

Finally, in Australia, the Ashcroft process has made possible the exploitation of the immense beds of zinc lead ore which exist in New South Wales. At one mine, that of Cockle Creek already referred to, more than two million tons of low-grade silver ore are in sight.[3] Large deposits of silver ore also exist in Tasmania.[4]

A third factor in the supply of silver which has doubtless exerted a considerable influence is the silver standard prevailing in Mexico and the Central and South American silver countries. The miners' wages are paid and most of the supplies are purchased in terms of the silver standard. Domestic prices and wages have not varied with the price of silver, and, by consequence, the fall in silver has not affected the profits of mine owners to the same extent as in the United States. Their expenses in silver remained at about the same figure and their only loss came from a lower rate of profits measured in gold. This fact has placed mining operators in silver-standard countries at an advantage in competition with their competitors in the United States and Europe, and has doubtless to some extent increased the supply of silver, though we should be careful not to exaggerate its importance.[5] This advantage accruing to the mine owner has not been at the expense of the laborer except in so far as the laborer has been a consumer of imported com-

[1] *Report of Director of Mint on Production of Gold and Silver*, 1891, p. 233.

[2] *Report of Director of Mint on Production of Gold and Silver*, 1894, p. 244, quoting official report of the Japanese department of mines: "The mineral wealth of this country as now known is something enormous, ... gold, silver . . . . in these and other provinces seems almost inexhaustible."

[3] *Australian Mining Record*, January 1897.

[4] *Report of the German Monetary Commission*, cited above, Note 1.

[5] *Report of Director of Mint on Production of Gold and Silver*, 1894, p. 208: "The fact that all laborers in the mines are paid in silver renders the cost of production extremely low . . . . The lesser sterling value of the wages paid compensates to some extent for the fall in the value of silver, the wage rate not having risen since the recent heavy fall in silver." *Cf.* also *Special U. S. Consular Report on Money and Prices in Foreign Countries*, pp. 116, 117, 122, and 145.

modities. He receives the same amount of silver, and with that silver buys practically the same quantity of food, clothing, and shelter in so far as these are the productions of his own country. It is not to be expected that this superiority of the silver producers in silver-standard countries will long remain. With the growth of international exchange, the decline in silver is destined finally to make itself felt in even these backward communities, though the natural inertia of prices, unassisted by credit expansion, may for a time delay this result.

To summarize this portion of our study: We find that the increase in the supply of silver, which has been the main cause of its fall in price, has been due to the application of improved processes and appliances to a series of ore discoveries extending over the last thirty years; and that this advance of improvement has constantly lowered the cost of producing silver.[1]

The foregoing discussion authorizes a brief examination of the major premise of the bimetallic argument, viz., that it is possible, by the joint action of Europe and the United States, to establish a parity between the two metals at a ratio of 15½ or 16 to 1, by the admission of both to free coinage at one of these ratios.[2]

The first prerequisite to the realization of this plan is to overcome the prejudice against silver and in favor of gold which so evidently exists among the business classes. Their coöperation is necessary both to the enacting of a bimetallic law and to its support. It would be useless for legislation to declare one ounce of gold equal to sixteen ounces of silver if the persons most interested refuse so to receive it. We may well question the foundations of this prejudice. With the growing use of paper representatives for coin, the advantages in weight which

[1] I am glad to acknowledge my indebtedness to Dr. Nichols, Assistant Curator of the Department of Geology, Field Columbian Museum, for his valuable suggestions and kindly assistance in the preparation of this part of the present article.

[2] I omit, for obvious reasons, any discussion of the practicability of so-called "national bimetallism." Few writers of repute have deemed this practicable, and some of the strongest supporters of international bimetallism, notably General Walker, have earnestly opposed independent action on the part of the United States.

gold has hitherto enjoyed over silver as a medium of exchange have largely disappeared. Metallic money is today seldom employed even in the United States and Great Britain, while the rapid spread of credit facilities upon the continent argues for a similar condition there. As a basis for representative money the advantage which $1000 in gold enjoys over the like amount of silver is only in respect to its greater portability. But since transportation charges on the precious metals are estimated on a basis of value alone for gold, and of both weight and value for silver, this advantage is considerable.[1] The assumption upon which most of the current prejudice is based, that gold is more stable in value than silver, is not at all points substantiated by the facts. A comparison of the relative movements of general prices and silver since 1873 shows silver, during this period, to have been more stable in value than gold, if stability be reckoned on the basis of the fluctuations of prices and silver.[2] But whatever the foundation of this prejudice, its existence and strength cannot well be denied, and must be reckoned with in any attempt to treat gold precisely as silver.

Assuming this objection to have been overcome, and the mints of the world to have been opened to the free coinage of gold and silver at one of the old ratios, it is interesting to note the probable effect of this action upon the market ratio. The immediate result would doubtless be a great rise in the value of silver. To the extent to which gold would be withdrawn from circulation, to that extent would an additional demand be created for silver which would tend to equalize the two metals, at the mint ratio, even if the value of gold was not materially lessened by the increased supplies going into the arts. Speculation is useless as to the probable extent of this rise in silver;

[1] Charge on $1000 from Chicago to New York, on gold, $1.25; on silver, $1.25 + $2.50 per hundredweight; $1000 in silver weighing 60 pounds, total charge would be $2.75. These figures were furnished by the Adams Express Company.

[2] *Cf.* note on "Gold and Silver in Terms of Commodities," in the JOURNAL for March 1897. It was there shown that, even taking the period 1850 to 1895, silver had on the average maintained a greater stability of purchasing power than had gold, and that since 1873 the advantage lay decidedly with silver.

but since the increased demand would fall practically on the yearly production, there is reason to believe that the immediate advance would be considerable. It is not a valid objection to this conclusion to assert that the exchange value of the entire amount of silver in existence must be raised, for we have already shown that only that part which either is, or is expected to be, within the market can affect the price. The fears of large sales by Europe are not well founded. If these nations which hold large quantities of silver were to consent to the establishment of international bimetallism, it is unlikely that they would combine to defeat the success of their own measure by selling such silver as chanced to be in their possession. Nor is it likely that any considerable quantity of silver would come from the arts or from the stores of India to enter the silver market, if we may judge from past experience. The standard might be lowered, or it might remain unchanged, according as the effect of a bimetallic law was to equalize the two metals by raising silver without lowering gold; or by raising silver and depressing gold; or by merely raising silver without any equalization of that metal with gold. In any event, the lowering of the standard would not be to the present value of silver.

But that a decline to the present value of silver could long be postponed, from our previous examination of the possibilities of silver production, it is impossible to deny. The application of improved methods to the tremendous silver resources of the world, an application greatly stimulated by the increased profits arising from a higher value of silver, would without doubt expand the production to meet any conceivable increase in demand. Silver would fall to a point where its supply could be regulated by cost of production; and the world would have descended to a lower standard. Whether, under these circumstances, the circulation would be composed of both silver and gold is difficult to decide, and we will not now attempt a decision. If the demand from the arts were sufficient to absorb the available supplies of gold before it reached a parity with silver at the mint ratio, the world's business would be done with

silver alone. If this demand were not sufficient, both silver and gold would without doubt remain in more or less concurrent circulation.

In conclusion, it is important to observe that with the standard regulated by the production of silver the result, at least for some years to come, would be a greater stability of prices than has been the case since 1873. Silver, as we have seen, can no longer be considered as a precious metal. The element of discovery in its production has practically disappeared, and its supply, like that of iron, copper, or lead, is dependent only on the application of capital to well-known ore deposits. This fact places it on a parity with the great mass of extractive products, and warrants an opinion that as they become more or less abundant, the production of silver would be correspondingly influenced. Whether this would be a desirable result, viz., a condition of stable prices, it is not in the scope of this article to decide; but it is pertinent to our inquiry to point out that such would be the probable outcome of the admission of silver to the mints of the world on equal terms with gold.

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